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DIFFUSE CEILING INLET SYSTEMS AND THE ROOM AIR DISTRIBUTION

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Introduction

This paper describes a new air distribution system which is able to remove a large heat load from a room without creating thermal discomfort in the occupied zone of the room 1. The supply opening consists of the whole ceiling where air is supplied through standard acoustic ceiling elements and through the slots between the ceiling elements. It is characteristic for this type of air distribution system that it is the heat sources in the room that generates the air flow pattern in the room and the attendant draught. Few examples of this system are known in comfort ventilation, but it is used extensively in livestock buildings. Figure 1 shows the design chart for a typical system indicating the limit for flow rate qo and temperature difference over the system ΔTo giving a draught of 0.15 cm/s in the occupied zone 1. The product of qo and ΔTo is constant, which is typical for all systems with low supply velocity where heat loads generate the flow in the room.

Full scale experiments

The system is tested in a full-scale room with the length, width and height equal to 4.1 m, 3.2 m and 2.45 m, respectively. Both cooling and heating (for unoccupied buildings during night time) are tested.

Results and conclusions

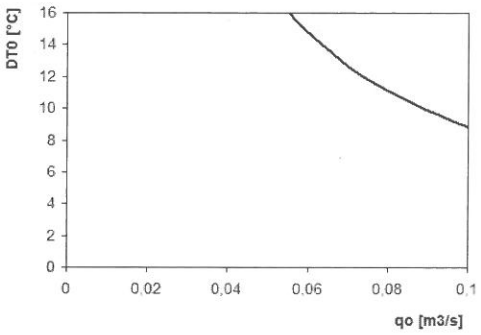
Both smoke and comfort experiments where made. The smoke experiments (3.5 to 8.0 h-1) show that the influence of the return opening location could be ignored. Velocities are low in the occupied zone but high very close to the ceiling and the slots in the ceiling. The occupied zone should have a distance of at least 0.5 m from the ceiling due to this velocity level. The comfort experiments consist of one cooling experiment (8 h-1) and two heating experiments (3.5 and 6.0 h-1). The cooling experiment shows low velocities in the room and a very small temperature gradient.

The system is difficult to use in case of heating because we should expect a very large vertical temperature gradient, but the experiments show that a small heat load in the room will generate sufficient mixing and ensure an even temperature in the room (2 to 3oC from floor to ceiling).

Literature

1. P. V. Nielsen and E. Jakubowska, The Performance of Diffuse Ceiling Inlet and other Room Air Distribution Systems, Cold Climate HVAC, Sisimiut, Greenland, 2009

Design chart for a room with diffuse ceiling inlet



Full scale room with location of the heat loads (Wall (cold/warm), Manikin, Computer and lamp).